

# PDL 800-D

Picosecond Pulsed Diode Laser



Laser Driver for LDH Series Laser Heads



User Manual

Document version 2.0.4



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# 1. Introduction

The PDL 800-D is a pulsed diode laser driver unit featuring easy-to-use controls for both optical output power level and pulse width as well as the repetition frequency. Peak powers up to 1 Watt and pulses as short as 50 ps (FWHM) at repetition rates from single shot up to 80 MHz can be generated, depending on the diode laser head of the LDH Series in use. Additionally, the PDL 800-D supports the continuous wave (cw) mode of the LDH-D-C laser heads.

## 1.1. The Laser Driver Unit

The driver unit features a pulse generator that generates a low jitter clock signal. The internal clock generator consists of two selectable master oscillators and a frequency divider. The master oscillators typically run at 80 and 1 MHz and can be divided by a factor of 1, 2, 3, 4, 8, 16, or 32. Thus covering a repetition rate range from 31.25 kHz to 80 MHz.

Alternatively, the laser pulses can be triggered by an external trigger signal. This way the PDL 800-B can be synchronized with other instruments over the full frequency range from single shot to 80 MHz. A permanently active sync output allows the PDL 800-B to trigger other devices such as TCSPC electronics.

## 1.2. Supported light sources

The PDL 800-B driver is designed for operation with the following light sources:

- LDH Series picosecond pulsed diode lasers, including the LDH-P, LDH-P-C, LDH-P-F, LDH-P-FA, and LDH-P-TA models
- LDH-D-C cooled dual-mode (pulsed and cw) laser diode heads
- PLS Series sub-nanosecond pulsed LEDs

## 1.3. Laser Diode Heads of the LDH Series

The LDH Series laser heads are all based on compact semiconductor units called diodes. Applying an electric current to these diodes leads to the emission of laser light. The picosecond pulsed laser diode heads of the LDH-P Series are compact, easy to use, and require no beam alignment. They contain a laser diode as well as special control electronics that are matched to the diode. A laser system based on an LDH laser head consists of said laser head combined with the PDL 800-B laser driver.

Laser heads from the LDH Series cover a broad spectral range from UV to NIR with different optical output powers and spectral bandwidths. The laser heads can be operated at repetition rates of up to 80 MHz and deliver pulses with widths down to 40 ps with average pulse powers in the lower mW range. Wavelengths can be quickly and easily change by exchanging the connected laser head or LED.

The laser heads feature collimating optics, which can be optionally replaced with fiber couplers for single- or multi-mode optical fibers. Some of these laser heads also included a thermoelectric cooling (Peltier) element for temperature stabilization.

The laser heads contain a diode element and a power driver stage that features various adjustments and protection circuits. These parts are internally calibrated and then sealed after final inspection. Any tampering with these calibrations will void the guarantee.

The only user adjustable part of the laser head is the set-point for the thermoelectric (TE) cooler (LDH-P/D-C Series only).

## 2. Safety Related Information

### 2.1. General Safety Instructions



#### LASER Warning!

LDH Series diode laser heads are available at different wavelengths and intensities. Some laser heads can emit infrared light. Infrared light is not visible to the eye! **These laser modules can emit laser light of up to class 3B / IIIB.**

Lasers can be hazardous and have unique safety requirements. Permanent eye injury and blindness is possible if lasers are handled incorrectly. Pay close attention to each safety REMARK and WARNING statement in the user manual. Read all instructions carefully BEFORE operating this device.

The laser driver systems and diode heads of the LDH Series are manufactured according to the International Laser Safety Standard IEC 60825-1:2007 and comply with the US law 21 CFR §1040.10 and §1040.11.

#### Required Laser Safety Measures

Please observe the laser safety measures for up to class 3B / IIIB lasers in accordance with applicable national and federal regulations. The owner / operator is responsible for observing the laser safety regulations.

#### What does the owner / operator have to observe?

- The owner / operator of this product is responsible for proper and safe operation and for following all applicable safety regulations.
- The owner / operator is fully liable for all consequences resulting from the use of the laser for any purposes other than those listed in the operating manual. The laser may be operated only by persons who have been instructed in the use of this laser and the potential hazards of laser radiation.
- The owner / operator is responsible for performing and monitoring suitable safety measures (according to IEC/EN 60825-1 and the corresponding national regulations).
- The owner / operator is also responsible for naming a laser safety officer or a laser protection adviser (according to the standard IEC/EN 60825-1: "Safety of laser products, Part 1: Classification of systems, requirements and user guidelines" and the respective national regulations).
- When using lasers of class 3B / IIIB, it is required to wear special eye protection (laser safety goggles).

**The following security instructions must be followed at all times.**

#### General Safety Instructions for Operation

- Never look directly into a laser beam or a reflection of the laser beam. Avoid all contact with the laser beam.
- Always switch the laser driver fully off before removing or changing a laser head or a fiber coupler.
- Do not introduce any reflective objects into the laser beam path.
- Every person involved with the installation and operation of this device has to:
  - Be qualified
  - Follow the instructions of this manual
- As it is impossible to anticipate every potential hazard, please be careful and apply common sense when operating laser heads from the LDH Series. Observe all safety precautions relevant to Class 3B / IIIB lasers.

- Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.
- **Do not open the housing of either laser head or driver unit** under any circumstances! There are no user serviceable parts inside. The only maintenance needed is the visual inspection for external damage and cleaning of the housing.
- For safety reasons, you should periodically check (on a monthly basis) the function of the emission indicators and remote interlock on the laser driver, as well as verify that no scattered radiation can escape the collimator (e.g., by missing screws).
- Only use laser heads supplied by PicoQuant with the PDL 800-B laser driver.

## 2.2. Safety Labels on the Laser Device

The safety labels are affixed to the top of the laser head housings, with an arrow pointing towards the laser emission aperture (see Fig. 1 for some examples). The label states the laser product classification, certification, power, and wavelength range relevant for the classification.

Please refer to the *laser delivery report* in the Appendix for information on the central emission wavelength, maximum achievable optical output power, and pulse shape of the delivered LDH laser head.

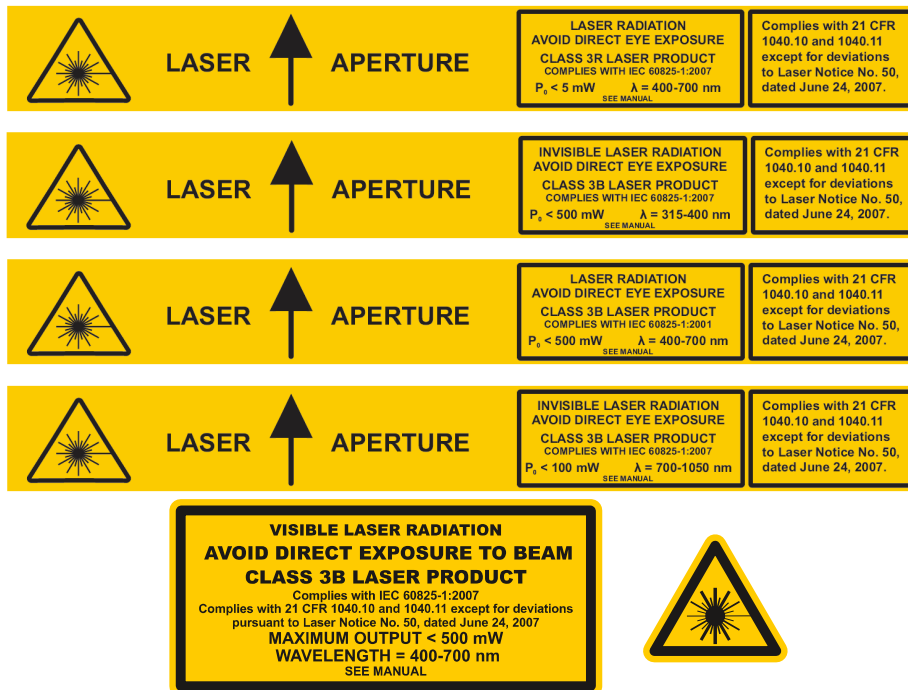


Fig. 1: Example of laser warning, certification, and laser classification label on laser heads of the LDH Series. Top: labels for cylindrical laser heads; bottom: label for box-shaped laser heads.

## 2.3. Remote Interlock

In order to meet laser safety regulations, it might be necessary to install a remote interlock, e.g., a door switch, to deactivate power to the laser when the door to the laser area is opened. Remote interlock connectors are provided on the laser driver for this purpose. Removing the connector or breaking the interlock circuit will immediately deactivate the lasers power supply.

The remote interlock connector is located on the back panel of the PDL 800-D, just below the cooling fan, as shown in fig. 6.

In order to install a remote interlock, remove the bridge and connect your remote interlock (door) switch to the "REMOTE INTERLOCK" connector. Standard banana plugs can be used for the connection. The loop resistance of the cabling plus the switch must be less than 10 Ohms. The voltage that is present on this connector is < 7 VDC.

## 3. Installation and Quick Start

The number labels used in this chapter refer to the hardware elements shown in figs. 5 and 6. Before making any connections, be sure that all of the following conditions are met:

- *Main power ON / OFF switch (17)* is in the “0” position.
- *Line voltage selector (16)* is set to the correct voltage
- *Laser key switch (2)* is set to the “STBY” (standby) position.
- *Laser intensity control (10)* is set to the lowest setting

### 3.1. Electrical Power and Signal Connections

#### 3.1.1. Connecting the Laser Head to the Laser Driver

Changing or connecting a laser head to the *laser head output connector (5)* is a straightforward task, but a few points need to be taken into account. Following the step-by-step guide given here is strongly recommended.

- **WARNING! Before unplugging a laser head from your laser driver, make sure that the laser driver is fully switched OFF!**
  - **Laser heads from the LDH Series (and their respective drivers) do not support “hot-plugging”.**
- Laser heads from the LDH Series have only a single cable to connect them to their respective laser drivers.
  - The sole exception are high powered variants of the “FA” and “TA” Series where an additional external power supply is provided.
  - This additional power supply needs to be plugged into a power socket to operate these lasers. This power supply is not meant to be connected to the laser driver.
  - Only the unit originally supplied with the laser head should be used.
- Both the cable plug and the socket on the laser driver have a red alignment mark indicating how the should be connected: Match the red mark on the cable plug with the red dot on the socket before plugging the cable in.
  - Please note that laser heads of the LDH-S and LDH-M type cannot be connected to a laser driver from the PDL Series as their cable plugs are different. The same is also true for the LDH-P/D laser heads with respect to the MDL and FSL laser drivers.
- Make sure that the newly connected laser is firmly attached to its base plate or optical bench and that the beam aperture or the exit of the optical fiber is oriented in such a way as to pose not eye hazard **BEFORE** turning it on.

#### 3.1.2. Other Signal Connections

- Connect (if necessary) the “*REMOTE INTERLOCK*” (13) to a switch loop (see below) or use the installed short circuit bridge if no remote interlock is needed.
- If desired, connect an external trigger signal to the “*TRIGGER IN*” connector (8).
- If desired, connect the “*SYNC OUT*” connector (12) to an external device, such as a TimeHarp or PicoHarp TCSPC unit or an oscilloscope.
- Plug in the power cable.

#### Remote Interlock Connector

In order to meet laser safety regulations, you may need to install a remote interlock, e.g., a door switch, to deactivate power to the laser when the door to the laser area is opened. The “*REMOTE INTERLOCK*” connector (13) on the back panel is provided for this purpose. When the contacts are open the power supply of the laser is then disabled.



Remove the bridge and connect your remote interlock (door) switch to the “*REMOTE INTERLOCK*” connector (13). Standard banana plugs can be used for the connection. The loop resistance of the cabling plus switch must be less than 10 Ohms. The voltage that is present on this connector is < 7 VDC.

### 3.2. Heat Dissipation

#### Driver Unit:

Please ensure free air circulation around the unit and do not cover the cooling fan at the back panel.

#### Temperature Controlled Laser Heads (LDH-C Models):

The LDH-C series laser heads contain an active thermoelectric cooling mechanism. Depending on the ambient temperature, this can produce a considerable amount of heat at the housing.

Sufficient air circulation must be ensured to prevent overheating of the laser head. If possible, mount the laser head on little posts as shown in fig. 2 to allow air convection around the whole surface. Mounting material as shown there is available from PicoQuant as an accessory.

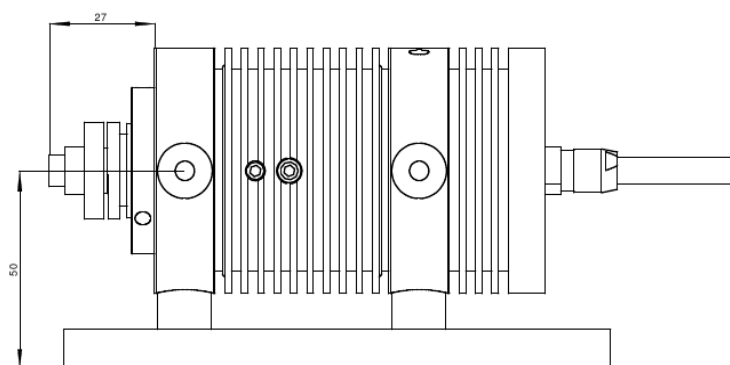


Fig. 2: LDH-C laser head mounted on posts, allowing for air convection.

#### Standard Laser Head (LDH Models)

The output power of laser heads without temperature stabilization changes with the case temperature. They deliver better long term stability if they are operated in a temperature conducting mount.

If you own a high power, but not temperature controlled laser head, an extra heat sink may be required. Otherwise the self-heating of the laser head might lead to a significant drop in optical output power and also a shorter lifetime of the laser diode. The Laser Delivery Report in the Appendix will indicate if a heat sink is required. Mounting the laser head into a metal bracket directly connected to a surface of some square centimetres is sufficient in most cases.

### 3.3. Adjusting Temperature Set-point (LDH-C Laser Heads Only)

The only user adjustable part of the laser head is the set-point for the thermoelectric (TE) cooler. Since the output power at a given potentiometer setting depends slightly on the temperature of the diode element, the set-point should only be changed if absolutely necessary, e.g., if the ambient temperature is too high.

The thermoelectric (TE) cooler maintains the temperature of the diode element and collimating optics at a constant level. The factory pre-set value is approximately 20 °C. Before first operating the diode laser, verify that the temperature control potentiometer is set correctly. The desired temperature can be set via the Set-Point Adjustment potentiometer (see fig. 3) using a screwdriver.

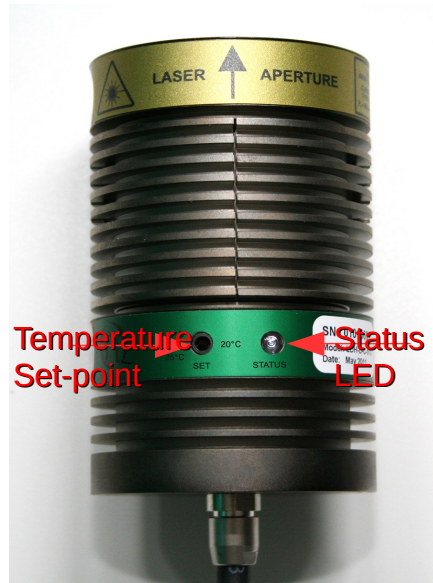


Fig. 3: Top view of a LDH-C laser head with temperature set-point potentiometer and status LED.

The temperature level can be set from +15 to +25 °C. The temperature should be chosen with respect to the ambient temperature and humidity conditions. The outer case acts as a heat sink. To prevent overheating, the temperature should not be set to the lowest value if the ambient temperature is higher than 30 °C. Also, water may condense on the collimator if the ambient humidity is high. **Switch the laser OFF** and look at the collimating lens to determine if condensation is forming. **DO NOT look into the laser optics when the laser is ON!**

**CAUTION !** Please note that adjusting the set-point temperature is not meant to be a “daily” process. Constantly changing the temperature set-point will wear out the plastic adjustment screw. Only change the set-point value if the temperature in your laboratory is regularly above (or below) +20 °C.

The temperature of the diode element needs to reach the set-point temperature for stable operation. If the diode temperature is too high, as indicated a red emitting “STATUS” LED, the laser will be switched off. At start-up the “STATUS” LED may be red. Allow 2 to 5 minutes after start-up, under normal conditions, for the TE cooler to reach the set-point temperature. The “STATUS” LED will change to green when the temperature has reached the set-point.

Check the temperature control “STATUS” LED on the laser head, if it is:

- green - the laser diode is operating at the set-point temperature
- red - the laser diode temperature is too high and the laser will automatically turn off

Check the “STATUS” LED periodically. If it is red, the TE cooler is operating but not able to maintain the temperature of the diode element. In this case, switch the laser off and wait until the laser head has cooled down. Then, either adjust the temperature set-point to a higher value, reduce the ambient temperature or increase the ventilation near the diode laser housing.

**At higher operating temperatures the diode laser can provide approximately 10 % more output power, but the diode element lifetime will be much longer if it is operated at a lower temperature.**

### 3.4. Continuous Wave Operation

The PDL 800-D driver allows using the continuous wave (cw) operation mode of the LDH-D-C laser heads. This mode is selected by switching the “TRIGGER SOURCE” selector to “CW”.

Note that significantly higher optical output powers will be produced in cw compared to pulsed mode, especially at low repetition rates. In this operation mode, the optical output power can be adjusted in the same way as in pulsed mode through the “INTENSITY” potentiometer (10).

During cw operation the synchronization output (12) delivers the same signal as in the “INT1” setting of the “SOURCE” selector (9). This can be useful to perform correlation measurements with TCSPC electronics such as the TimeHarp or PicoHarp.

### 3.5. Fiber Coupling

Fiber coupling is an option for LDH Series laser heads depending on their emission wavelength. The heads can be equipped with either single-mode (SM) or multi-mode (MM) fibers as well as with polarization maintaining (PM) fibers. If applicable, the fiber type for each specific laser head is indicated in the individual Laser Delivery Report in the Appendix.

**CAUTION !** Please do not remove the optical fiber from the coupling optics as the adjustment of the coupling will be lost! Re-adjustment is a demanding task and requires an experienced operator.

### 3.6. Polarization

The laser beam which is emitted from the collimated output is linearly polarized. The polarization extinction ratio for diode lasers is typically about 20dB or 100:1. The polarization plane of the laser output is indicated by a small label on the back of the laser head. Note that the polarization might be different for different types of laser heads.

### 3.7. Triggering Other Devices with the Synchronization Signal

Each laser pulse also generates an NIM standard signal ( $< -800$  mV at 50 Ohms) at the *synchronization output* (“SYNC OUT”) port (12). This provides the opportunity to synchronize the laser with multiple light sources or other devices for time correlated measurements.

The sync out signal is always synchronized to the trigger source (i.e. INT or EXT depending on the setting of the *trigger source selector* (“SOURCE”, 9)). In cw mode, a synchronization signal according to the settings of the “INT1” mode is applied to the “SYNC OUT” port.

If you only need the synchronization signal without laser pulses (i.e. for installation and adjustment), switch off the laser with the *laser key switch*. The synchronization signal will still be present, running according to the settings of the switches (9) and (11).

### 3.8. Gating

For special applications such as in scanning devices, the PDL 800-D features two gating functions which allow suppressing laser emission by an external signal.

#### Fast Gate

The Fast Gate function affects the triggering mechanism. It is effective when the module is being triggered either from the internal oscillators or from an external source. If the laser is operated in cw mode then the fast gate input has no effect.

This gating function can perform transition within nanoseconds; assuming a precise timing, it can switch between two laser pulses even at high repetition rates. However, a certain settling effect will be observed due to thermal effects. The temporal position and pulse height might be different for a certain amount of pulses at the beginning of a burst. The actual settling time depends on the laser head and driving conditions. Longer burst length or shorter burst periods help to increase the percentage of stable pulses in one burst. Finding a good ratio between burst lengths and periods is an empirical process to minimize the influence of the settling effects on the measurement results.

To use the fast gating mechanism, connect a high-active TTL signal to the “FAST GATE” input connector (15). This input has an internal pull up resistor to TTL “High” level.

The yellow “PULSED” LED (4) will turn off when the Fast Gate has switched the laser off for more than 100 ms.

## Slow Gate

The *Slow Gate* function works by influencing the voltage that controls the optical output power. Laser emission is thus switched off by setting this voltage to zero when the *Slow Gate* activates. The advantages of this method are that it works regardless of the active trigger mode and drift effects are minimized. However, this is a rather slow modulation compared to the high repetition rate pulses.

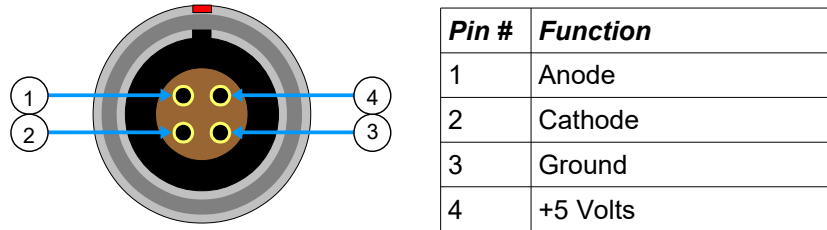


Fig. 4: Pin assignment of the SLOW GATE input port.

The *Slow Gate* input is isolated by an opto-coupler and a current must be fed into the input to activate the laser. Applying a voltage of 5 V to pin 1 and 2 of the connector activates the laser. When this gating function is not used, a bridged connector that connects pin 2 with 3 and pin 1 with 4 must be plugged into the “*SLOW GATE*” connector (15) to always keep the laser active. This bridge connector is installed per default at the factory.

Note that when using *Slow Gating*, only the laser head is gated. The yellow indicator lamps will still be on when the laser is switched off by the *Slow Gate* signal.

## 3.9. Quick Start Guide

### 3.9.1. Powering up the PDL 800-D

- Put the laser key switch (2) to the stand-by position (“*STBY*”).
- Ensure that all laser safety instructions as outlined in chapter 2 are observed.
- Switch the *main power switch* (17) to ON and the green “*STBY*” (*standby*) LED (1) will light up.  
**If the laser key switch (2) was not in the “*STBY*” position when the *main power switch* (15) was turned on, then laser output will be blocked for 10 seconds. After that time span, the laser will start emitting according to the settings on the front panel!**
- Set the “*TRIGGER SOURCE*” selector (9) to the appropriate position:  
INT1 - Pulsed mode, triggering from the first internal oscillator (usually 80 MHz)  
INT2 - Pulsed mode, triggering from the second internal oscillator (usually 1 MHz)  
CW - Continuous wave mode  
EXT - Laser is triggered by an external signal, provided that the *trigger level threshold* (5) is set correctly
- If the laser head is triggered by one of the internal oscillator, set the desired repetition rate by selecting the appropriate divider value with “*REP. FREQUENCY*” switch (11).
- If using a temperature stabilized laser head (LDH-C type), wait until the “*STATUS*” LED on the laser head turns green.
- Turn the laser key switch (2) to “ON”.
- The “*LASER ON*” LED (3) on the front panel of the PDL 800-B will light up in red when the trigger condition is met.
- Adjust the laser power level with the “*INTENSITY*” potentiometer (8).

If you cannot detect any laser emission, check the following:

Is the yellow "laser on" indicator LED (4 or 6) on?			
Yes		No	
Has the <i>Slow Gate</i> switched off? (see section 3.8) If no <i>Slow Gate</i> is used, a bridge must be plugged into the connector (14)	Trigger source selector (9)?		
	CW	INT	EXT
For temperature stabilized laser heads (LDH-C models): does the "STATUS" LED of the temperature control light green?		Is the selected frequency above an internally set limit (see section 3.9.2)? Check rear panel for a note.	Is the trigger level set correctly?  Does the triggering signal meet the specifications of pulse width and amplitude? See section 3.9.4
Is the "INTENSITY" control (5) set to the upper region?	Has the <i>Fast Gate</i> switched off? (see section 3.8) A short circuit on the "FAST GATE" connector (15) switches off the laser.		
	Is the <i>laser key switch</i> (2) in the "ON" position?		
	Is the <i>remote interlock loop</i> closed? See section 3.1		

**NOTE !** The output of pulsed UV-LEDs (PLS 265 to PLS 340) is hard to detect. The wavelengths are far from the visible spectrum and the output power is very low (in the  $\mu\text{W}$  region). You need to use a sensitive optical power meter or an appropriate indicator card to recognize any output.

### 3.9.2. Setting the Repetition Frequency

The repetition frequency (or rate) of the internal trigger signal can be chosen in the range from 31.25 kHz to 80 MHz. The triggering signal is derived from one of two internal crystal oscillators.

#### Base Frequencies

The base frequencies are typically 80 MHz and 1 MHz. The base frequency oscillator is chosen with the "TRIGGER SOURCE" switch (9). The setting INT1 selects the first oscillator (typically 80 MHz), while INT2 chooses the second oscillator (typically 1 MHz).

Oscillators with different base frequencies can be provided on request. Check the label on the rear panel for the actual base frequencies of your driver.

#### Binary Divider

The base frequency can be divided by six division ratios from 1 to 32. The repetition frequency divider is chosen with the rotary switch (11). The following table gives an overview of all possible repetition frequencies that can be derived from the internal oscillators at the standard base frequencies of 1 and 80 MHz.

Oscillator (9)	INT 1	INT 2
<b>Division ratio (11)</b>		
<b>1</b>	80 MHz	1 MHz
<b>2</b>	40 MHz	500 kHz
<b>4</b>	20 MHz	250 kHz
<b>8</b>	10 MHz	125 kHz
<b>16</b>	5 MHz	62.5 kHz
<b>32</b>	2.5 MHz	31.25 kHz

When the repetition frequency is changed, the average power of the laser will also change. As the pulse energy is constant for a wide range of repetition frequencies the average power typically doubles or halves respectively with each step of the *division ratio switch* (11).

Note that for repetition frequencies above 20 MHz, saturation effects can occur causing a slight drop in pulse energy and consequently lower average optical output power than expected.

High repetition frequencies can be blocked on request in order to safely operate of light sources with maximum repetition rates below 80 MHz. A note on the rear panel label will indicate such a reduced maximum frequency. When switching to an internally blocked frequency, the “*PULSED*” LED (4) will switch off.

### 3.9.3. Changing the Pulse Intensity

The energy of the laser pulses can be adjusted through the “*INTENSITY*” control (10). At higher settings, the pulses will not only be more intense but also longer and slight after-pulsing may occur.

Changing the repetition frequency may also change the pulse shape. In some instances, these changes can be compensated for by adjusting the “*INTENSITY*” control (10), in order to retain the desired pulse form.

In order to reach stable optical output power, allow the laser to warm-up for at least 20 minutes. This is especially important for temperature stabilized laser heads.

Some higher power laser heads may only operate in the upper range of the intensity setting. Keep in mind that operation at higher power levels decreases the lifetime of the laser diode. To ensure safer working conditions and to prolong the lifetime of the laser element, select a power setting that is as low as possible for your needs. Full laser power should only be selected if absolutely needed.

### 3.9.4. External Laser Triggering

The laser can also be triggered by an external signal source at any frequency.

1. First, set the *laser key switch* (2) to the “*STBY*” position.
2. Connect the trigger signal generator to the “*TRIGGER IN*” port (6). The maximum limits for the trigger signal input voltage are -5 and +5 V. To prevent reflections, the output impedance of the signal source as well as the characteristic impedance of the cable and coaxial connectors must be exactly 50 Ohms.
3. Set the “*TRIGGER SOURCE*” selector (9) to the “*EXT*” position.
4. Adjust the trigger level between -1 to +1 V with the “*TRIGGER LEVEL*” control (7). The trigger level may have to be optimized in order to achieve the shortest possible pulse width. If the pulses are significantly broader than with internal triggering or if there are multiple pulses, the external trigger signal is not ideally locked. Readjusting the trigger level may help with weak input signals. Ringing of the signal source can lead to multiple pulses. Consequently, the trigger level should not be set too close to zero.

When the “*PULSED*” LED lights up in yellow, laser pulses are triggered at the rising edge of the trigger signal.

#### Trigger signal recommendations

Special care has to be paid to the quality of the triggering signal. To maintain the picosecond pulse to pulse stability, the signal source itself must have the appropriate quality. A good trigger signal has steep slopes (of a few nanoseconds) with low noise and stable periodicity.

Although the trigger input is designed to be quite sensitive, the best results are achieved with amplitudes between 1 and 2 V and pulse widths greater than 5 ns.

When using TTL signals, an attenuator of 10 dB may deliver better results. As per specifications, the low level of a TTL signal may be as high as 0.8 V, which is already very close to the highest settable trigger level.

## 4. Hardware Description

### 4.1. Front Panel

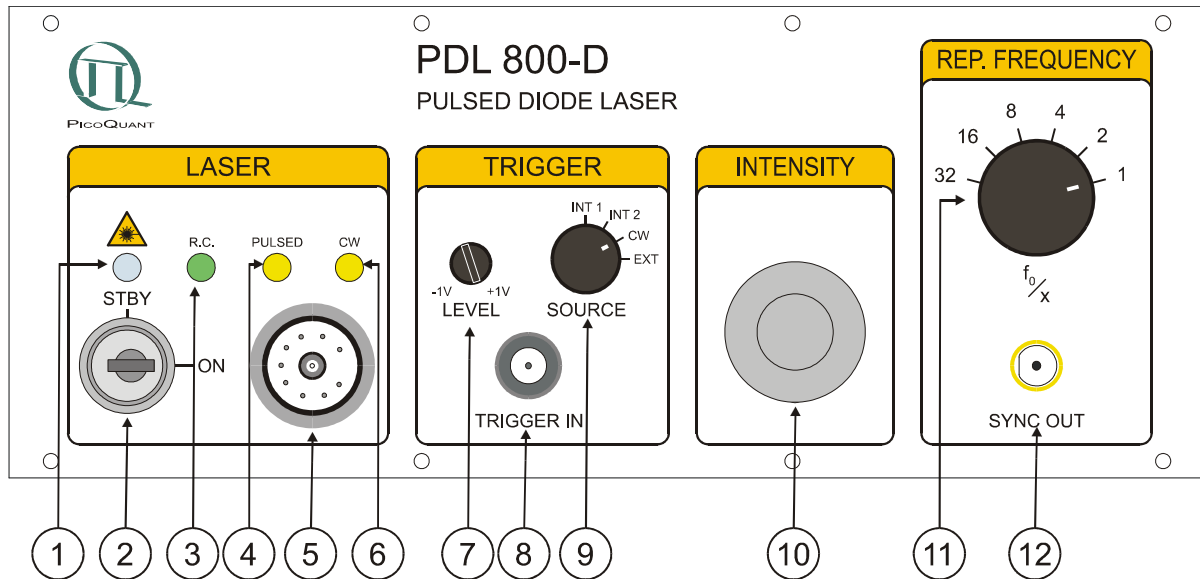


Fig. 5: Front panel of the PDL 800-D.

1. *Main Power indicator* – a white lit “STBY” (stand-by) LED indicates that the PDL 800-D is ON and that laser radiation can be emitted.
2. *Laser key switch* – power to the laser can be locked OFF by turning the key to the “STBY” position and removing the key.
3. *Remote Control* input port - (optional)
4. *Laser Pulsed* – a yellow lit LED indicates that the laser is running in pulsed mode and triggered.
5. *Laser output* port for connecting light sources(multi-pin connector)
6. *Laser CW*- a yellow lit LED indicates that the laser is running in cw mode
7. *Trigger level threshold* control
8. *External trigger input* port (female BNC connector)
9. *Trigger source selector* switch:
  - INT1 - Laser is triggered by the first internal oscillator (typically 80 MHz)
  - INT2 - Laser is triggered by the second internal oscillator (typically 1 MHz)
  - CW - Laser is running in continuous wave (cw) mode
  - EXT - Laser is triggered by an external signal, provided that the Trigger Level threshold (7) is set correctly
10. *Laser intensity control* - pulse intensity and length or cw -power can be adjusted
11. *Repetition frequency selector*: repetition frequency = base frequency divided by the selector setting
12. *Synchronisation signal output* port (SMA connector)

## 4.2. Back Panel

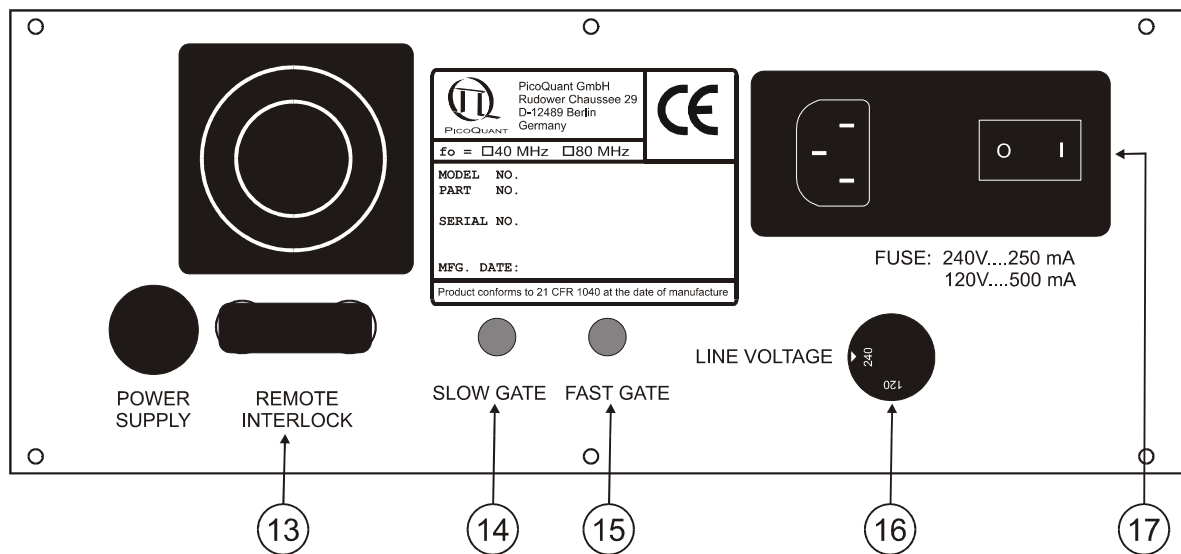


Fig. 6: Back panel of the PDL 800-B.

- 13. *Remote interlock* connector
- 14. *Slow Gate* input (see section 3.8)
- 15. *Fast Gate* input (see section 3.8)
- 16. Line voltage selector 120 / 240 V
- 17. Main power input socket with fuse and ON / OFF switch



## 5. Application Tips

The PDL 800-D is designed for indoor laboratory use. The laser diode element inside the laser head, is somewhat sensitive, i.e. overloads or stress may quickly damage it. Therefore, the laser head includes protection circuitry that may seem to hinder the user, but is absolutely essential for reliable, long-term performance.

### Remember to follow these basic operating rules:

- Ensure that the beam emitted by the laser head poses no danger for the eyes.
- Do not connect or disconnect the laser head from the base unit until the power has been switched OFF for at least 5 seconds.
- Do not connect the laser head to any driver other than the PDL 800-B or other drivers designated by PicoQuant as compatible. If unsupported supply voltages or signals are connected to the laser head, the system can be damaged and / or operate in an undefined state.
- The voltage at the external trigger input connector (8) should never exceed the range of -5 to +5 V, as the electronics may be damaged otherwise. To prevent reflections, the output impedance of the trigger signal source and the coaxial connector must be exactly 50 Ohms.
- There are no user serviceable parts inside the laser heads or the driver unit. Repairs or recalibration should be left to qualified personnel authorized by PicoQuant GmbH. Do not try to remove the 4 screws at the front of an uncooled laser head! Doing so will easily damage the laser diode.
- An external signal should only be connected to / disconnected from the *External trigger input (6)* connector when the *Trigger source selector (7)* is in the "OFF" position and the *Laser key switch (2)* is in the "STBY" (stand-by) position. This will prevent issues that might result in unwanted laser radiation.
- In order to ensure safer working conditions and to prolong the lifetime of the laser element, select a lower power setting (approx. 35% of full power). Full laser power should not be selected unless it is absolutely needed. This applies especially to laser diodes in the ultraviolet to blue spectral region, which have a more limited lifetime (around 1000 operating hours). It is recommended to switch off these lasers at the *trigger switch (7)* or the *laser key switch (2)* whenever possible. The main power switch of the driver can be left on to maintain the stabilized temperature.

### The pulse shape will be influenced by:

- Laser intensity setting - a higher intensity setting may produce:
  - Pulses with a higher amplitude and broader base. After-pulsing may also occur.
  - Peak shifting to an earlier time (arrives sooner) in relation to the SYNC signal.
  - Shifting of the peak emission wavelength to a shorter or longer wavelength (depending on the laser material).
- Repetition frequency - a higher repetition frequency may produce:
  - Pulses with a different shape or pulse width
  - Pulses with a lower peak power per individual pulse.
  - Pulses with lower energy per individual pulse.
  - In most cases, the energy of the individual pulses is not the same at each frequency setting, e.g., the energy at the 40 MHz setting is lower than at the 20 MHz setting. Changing the repetition frequency setting will not result in the same pulse energy unless it is  $\leq 10$  MHz.
- Polarisation / orientation of the laser - rotating the laser head by  $90^\circ$  may produce pulses with a different shape and intensity. This may also reduce the amount of background luminescence observed by the detector.

## 6. Technical Data / Specifications

### Internal Clock

Type.....crystal locked  
 Operation mode.....pulsed or continuous wave (cw)  
 Base frequencies.....1 and 80 MHz (selectable)  
 Repetition frequencies.....user selectable: 1, 1/2, 1/4, 1/8, or 1/16 of base frequency  
 .....80, 40, 20, 10, 5, or 2,5 MHz (80 MHz base)  
 .....1000, 500, 250, 62.5, or 31.25 kHz (1 MHz base)

### External Trigger Input

Amplitude.....-5 to +5 V (maximum limits)  
 Trigger level (adjustable).....-1 to +1 V (positive slope)  
 Required pulse width.....> 5 ns  
 Delay..... $35 \pm 5$  ns (from trigger input to optical output), jitter < 40 ps  
 Frequency range.....single shot to 80 MHz  
 Internal impedance.....50 Ohms (dynamic), 500 Ohms (static)  
 Connector.....BNC socket (female)

### Synchronization Output

Amplitude.....< -800 mV into 50 Ohms (NIM)  
 Pulse width.....6 ns  
 Delay.....12 ns (from falling edge to laser output), jitter < 20 ps  
 Internal impedance.....50 Ohms  
 Connector.....SMA socket (female)

### Gating Inputs

Slow gate.....transition time < 100 ms (pulsed and cw operation)  
 Internal impedance (slow gate).....> 500 Ohms  
 Connector type (slow gate).....4-pin LEMO socket – 00.304 Series  
 .....Example of connector: FGG.00.304.CLA  
  
 Fast gate.....transition time typically 10 ns (pulsed only)  
 Internal impedance (fast gate).....50 Ohms  
 Connector type (fast gate).....1-pin LEMO socket – 00.250 Series  
 .....Example of connector: FFA.00.250.NTA

### Remote Interlock

Voltage.....< 7 VDC  
 Loop resistance.....10 Ohms maximum

**Power Supply**

Line voltage.....220 / 240 or 110 / 120 VAC, 50 / 60 Hz  
Power consumption.....45 W maximum

**Dimensions**

Base unit.....237 x 310 x 97 mm (w x l x h)

**Operation Environment**

Temperature range..... 10 to 40 °C  
Rel. humidity.....< 80 %

**Retraction of Old Devices**

Waste electrical products must not be disposed of with household waste. This equipment should be taken to your local recycling center for safe treatment.  
WEEE-Reg.-No. DE 96457402



## 7. Support

### 7.1. Returning Products for Repair

If you have serious problems that require the device to be sent in for inspection / repair, please contact us at: [support@picoquant.com](mailto:support@picoquant.com) and request a RMA number before shipping the device. Observe precautions against static discharge under all circumstances in handling, packaging and shipping. Use original or equally protective packaging material. Inappropriate packaging voids any warranty.

### 7.2. PicoQuant Community Forum

This forum is intended as a platform for users of PicoQuant's systems, components and software packages. It is not strictly limited to software related questions. As PicoQuant products cover a wide range of applications from single molecule experiments to life sciences and material science, discussions of the scientific background are of course welcome. The forum can be found at <http://forum.picoquant.com>

## **8. Legal Terms**

### **8.1. Copyright**

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## 9. Further Reading

### 9.1. PicoQuant Bibliography

PicoQuant maintains a database of publications mentioning PicoQuant devices. It can be found at our website [www.picoquant.com/scientific/references](http://www.picoquant.com/scientific/references). It is a valuable source if you would like to know which laboratories are using PicoQuant products or how broad the field of various applications is.

### 9.2. Download of Technical Notes / Application Notes

PicoQuant, along with our customers, continuously writes and publishes short documents about techniques, methods and applications that are possible with our hardware or software. The download section can be found at [www.picoquant.com/scientific/technical-and-application-notes](http://www.picoquant.com/scientific/technical-and-application-notes)

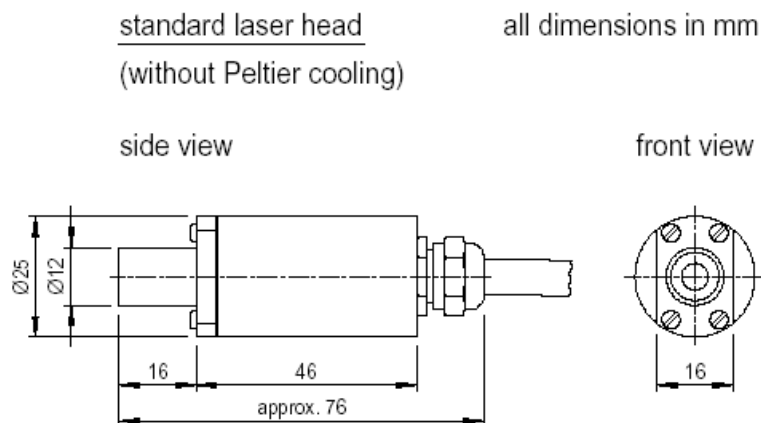
## 10. Appendix

### 10.1. Abbreviations

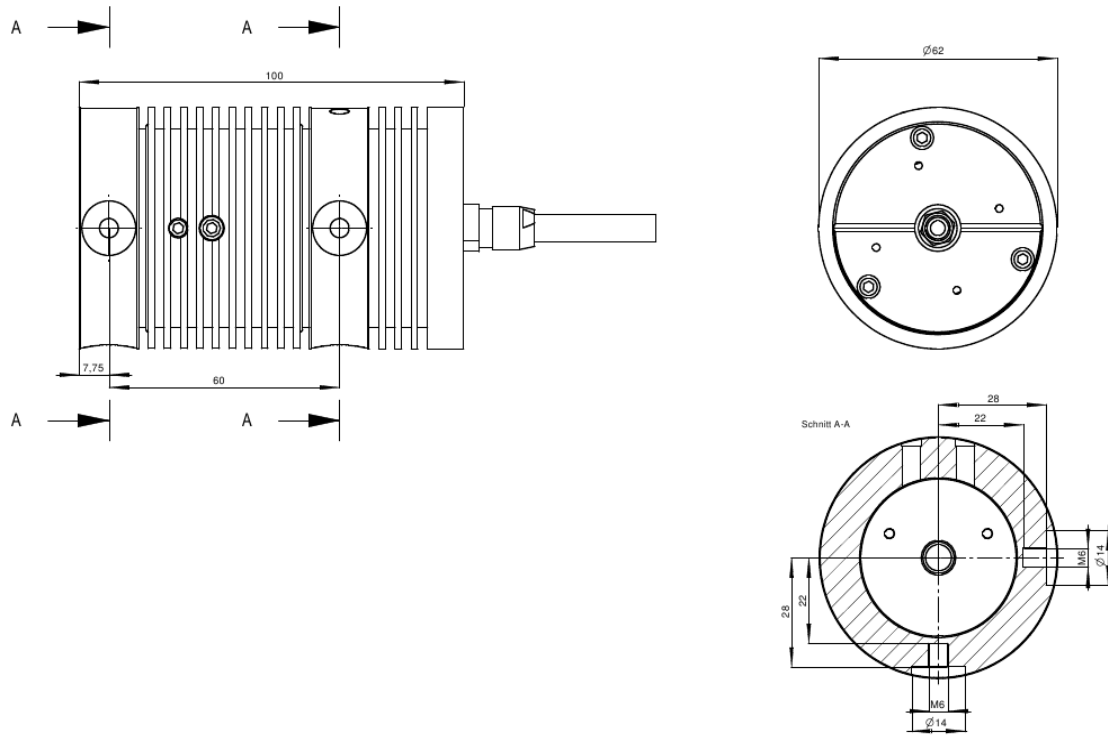
FWHM	Full Width at Half Maximum
LDH	Laser Diode Head
IRF	Instrument Response Function
LED	Light Emitting Diode
PMT	Photomultiplier Tube
NIM	Nuclear Instrumentation Methods
TTL	Transistor to Transistor Logic
SMA	Sub-Miniature version A (connector type)
TE	Thermoelectric (cooler)
SM	Single Mode (fiber type)
MM	Multi-Mode (fiber type)
PM	Polarization Maintaining (fiber type)
RMA	Return Merchandise Authorization
WEEE	Waste Electrical and Electronic Equipment
SPAD	Single Photon Avalanche Diode
cw	Continuous wave

### 10.2. Dimensions of LDH Series Laser Heads

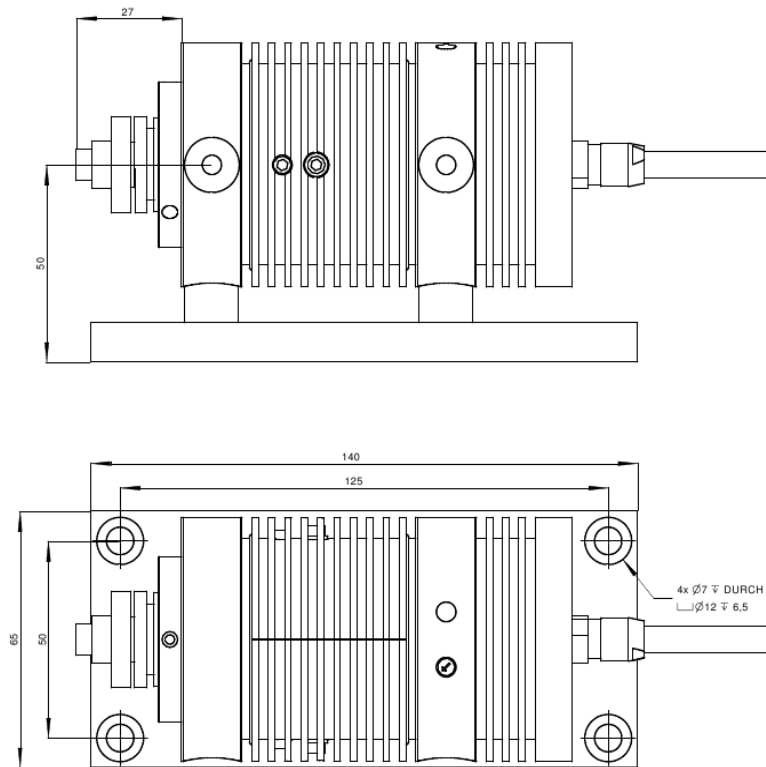
LDH model:



**LDH-C model:**

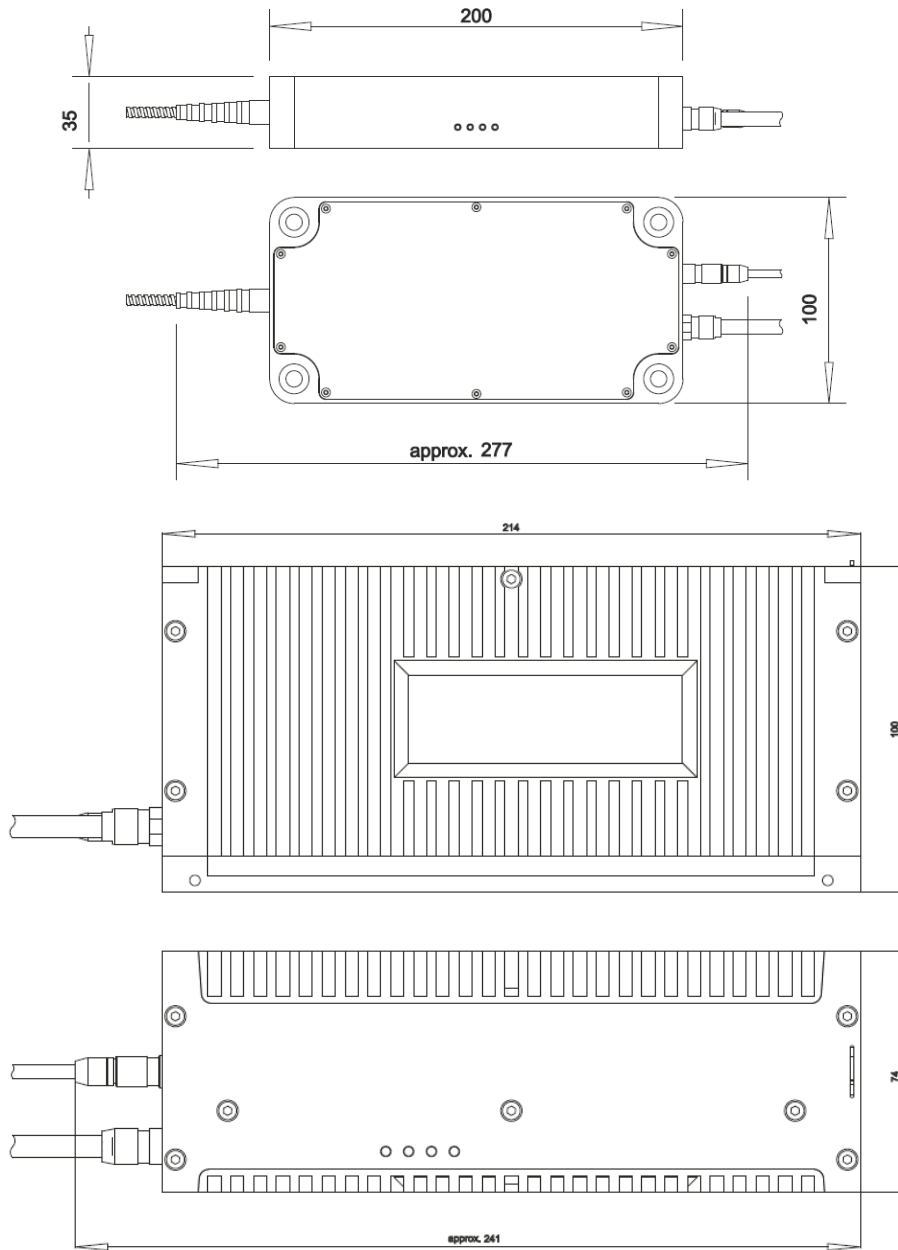


**LDH-C model on holder with fiber coupler:**





**LDH-FA models:**



**10.3. Laser Delivery Report**

The delivery report of your lasers, including all final production test results for pulse shape, optical power, and line width is attached to this user manual. A PDF copy can be provided on request.



All information given here is reliable to our best knowledge. However, no responsibility is assumed for possible inaccuracies or omissions. Specifications and external appearances are subject to change without notice.



PicoQuant GmbH  
Rudower Chaussee 29 (IGZ)  
12489 Berlin  
Germany

P +49-(0)30-1208820-0  
F +49-(0)30-1208820-90  
info@picoquant.com  
<http://www.picoquant.com>